(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 1 223 877 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
04.07.2007 Bulletin 2007/27

(21) Application number: **00972021.0**

(22) Date of filing: **05.10.2000**

(51) Int Cl.:
A61B 18/18 *(2006.01)* ***A61B 17/00*** *(2006.01)*

(86) International application number:
PCT/US2000/027611

(87) International publication number:
WO 2001/024720 (12.04.2001 Gazette 2001/15)

(54) SURGICAL INSTRUMENT FOR ABLATION AND ASPIRATION

CHIRURGISCHES INSTRUMENT ZUR ABLATION UND ASPIRATION

INSTRUMENT CHIRURGICAL D'ABLATION ET D'ASPIRATION

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE

(30) Priority: **05.10.1999 US 412878**

(43) Date of publication of application:
24.07.2002 Bulletin 2002/30

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Description

[0001] The present invention relates to electrosurgical instruments and systems for treating a surgical site on a human or animal body such as biological tissue by the application of energy. More particularly, the invention relates to surgical devices for applying high frequency energy to modify the characteristics of the tissue such as by ablation in combination with aspiration of any by-products from a surgical site.

[0002] Numerous surgical instruments for the treatment of biological tissue through the application of energy in a wide variety of medical procedures are known in the art. For example, U.S. Patent No. 4,593,691 to Lindstrom et al., U.S. Patent No. 4,033,351 to Hetzel, and U.S. Patent No. 5,403,311 to Abele et al. are examples of electrosurgical probes for use during an electrosurgical procedure such as for cutting or ablating tissue. U.S. Patent No. 5,458,596 to Lax et al. shows an example of an electrosurgical probe for the contraction of tissue by delivering electrical energy to the treatment tissue. Also, U.S. Patent No. 3,828,780 to Morrison and U.S. Patent No. 5,277,696 to Hagen show electrosurgical instruments which deliver electrical energy for coagulation during surgical procedures.

[0003] The use of these instruments typically involves the transmission of energy to a distal end of the electrosurgical probe or instrument. The distal end is inserted into the body to a surgical site of a patient to apply energy during the procedure. The frequency, power, and voltage generated by the electrical instrument and transmitted to the distal end are selected depending on the type of procedure for which the instrument is being used. For instance, such instruments are used for a variety of procedures such as heating, softening, shrinking, cutting and ablating tissue.

[0004] Because such instruments may be used for different procedures, the tissue (or other body part) being treated may respond differently depending on the treatment being performed. For instance, if the instrument is used to ablate the tissue, smoke and charring may be generated during the procedure or residual tissue debris may remain after treatment.

[0005] Unwanted air bubbles or excess fluid which may also be present in the treatment area may interfere with effective treatment of the tissue and should be removed from the surgical site during the procedure. Thus, it is desirable to provide an electrosurgical device for aspirating the region being treated to remove smoke, tissue debris, excess fluid and other unwanted matter from the tissue site being treated.

[0006] During the usage of prior instruments, however, such as in numerous of the above-mentioned instruments, the removal of unwanted matter generally requires the separate provision of an aspiration device. The use of two separate instruments increases the treatment time because the suction instrument must be separately inserted into the surgical site, used, and removed from the site before and/or after the electrosurgical treatment instrument is inserted or used at the site. Additionally, a separate suction instrument may be inserted into the surgical site through another access point which creates another portal in the patient's body which possibly creates further complications such as infection and scarring.

[0007] U.S. Patent No. 5,520,685 to Wojciechowicz, U.S. Patent No. 4,682,596 to Bales and U.S. Patent No. 4,347,842 to Beale disclose suction devices in various combinations and configurations with the electrosurgical probe. U.S. Patent No. 5,195,959 to Smith also discloses an electrosurgical device with suction and irrigation to supply electrically conductive fluid which adds even more material to the surgical site and would need to be removed during the procedure. Wojciechowicz, in particular discloses a suction coagulator with a suction lumen for the suction of by-products of electrosurgery through the instrument through a tip. Further, Hagen discloses a suction device for aspirating fluid through the surgical probe.

[0008] However, the arrangement of the suction lumen in relationship to the electrosurgical portion is such that blockage or clogging of the suction lumen can occur which could complicate the surgical procedure and unwanted or unnecessary ablation could occur. Charred and ablated tissue and coagulated blood often clog the tips of electrosurgical devices.

[0009] Therefore, it would be desirable to provide an instrument that may be used not only to treat a patient but also to aspirate the treatment area during treatment to simultaneously remove unwanted material. The surgical device and method should be simple and operate in a standard surgical environment. The electrosurgical instrument should provide the surgeon the ability to ablate, cut or coagulate in the same device while providing a suction means to aspirate surgical by-products from the surgical site. The suction and aspiration should be anti-clogging such that the device does not cause unwanted nor undesirable effects due to blockage. Such instrument and method should be able to precisely treat biological tissue with energy while efficiently allowing the surgeon to perform the medical procedure quickly without the need to utilize multiple instruments for the treatment.

[0010] The detailed description will be better understood in conjunction with the accompanying drawings, wherein like reference characters represent like elements, as follows:

FIG. 1 is a perspective view of an electrosurgical aspiration instrument formed in accordance with the principles of the present invention;

FIG. 2 is a cross-sectional view along axis A-A of FIG. 1;

FIG. 3 is an end view of a distal tip of the instrument of FIG. 1;

FIGS. 4A and 4B are cross-sectional and perspective views, respectively, of an alternate aspiration instrument of FIGS. 12A and 12B with an active elec-

trode having an ashtray configuration for mechanical grating and energy delivery with an internal return electrode;

FIGS. 5A and 5B are cross-sectional and perspective views, respectively, of the instrument of FIGS. 13A and 13B showing an external return electrode;

FIGS. 6A-C are detailed perspective, end, and cross-sectional views of the distal tip of an electrosurgical aspiration instrument according one embodiment of the present invention; FIG. 6A is a detailed perspective view of an active electrode with an aspiration opening; FIG. 6B is an end view of the active electrode; and FIG. 6C is a cross-sectional view along line A-A of the active electrode of FIG. 6B,

FIG. 7 is a perspective view of the complete electrosurgical instrument of the present invention showing a probe having a handle and a shaft with a distal tip for treatment with a suction line and control; and

FIGS. 8 and 9 are alternative embodiments of the distal end shaft of FIG. 19 according to the present invention having a pre-bent distal end in a 30 degree configuration and a 90 degree configuration, respectively.

[0011] Figs 1-3 show an electrosurgical aspiration instrument 10 capable of aspirating a patient treatment area within a standard surgical environment. It is not an embodiment of the present invention because of the form of the active electrode. It has a vaporizing electrode with a suction lumen and a "grate" cover. Electrosurgical aspiration instrument 10 is in the form of a probe having, generally, a shaft or elongate member 27 disposed along longitudinal axis A-A, a distal end or extremity 12 at which treatments are performed and a proximal end or extremity 14 at which instrument 10 is coupled to a power source (not shown) via power line 16. Power line 16 supplies energy to distal end 12 for treatment. The power source preferably permits modification and adjustment of the power, frequency, and voltage of the energy transmitted to distal end 12. A handle 17 may be provided to facilitate grasping of instrument 10 adjacent proximal end 14. At least one actuator 18, such as an aspiration control valve or switch or a power button may be provided. Preferably, a foot pedal (not shown) is provided to control power supplied to distal end 12 and actuator 18 controls aspiration through the instrument. Additional actuators or controllers, such as for adjusting the power, frequency, or voltage, may be provided either on instrument 10 itself or on the power source if desired.

[0012] Electrosurgical aspiration instrument 10 has an energy application surface or plane 20 formed by at least one electrode that applies energy to the patient area to be treated. Instrument 10 has at least two electrodes, active electrode 22 and return electrode 24 that cooperate to apply energy across surface 20. Electrodes 22 and 24 are formed from electrically conductive materials, for example a medical grade stainless steel, capable of withstanding the high temperatures resulting from use of instrument 10. It will be appreciated that the material that is selected for electrodes 22 and 24 has defined conductivity characteristics that affects the power necessary to achieve the desired treatment operation.

[0013] As shown in FIGS. 1 and 2, active electrode 22 is positioned at the open distal end of shaft 27 of electrosurgical aspiration instrument 10. Although shaft 27 may be a separate element, preferably, return electrode 24 serves a dual purpose as both the return electrode that completes the energy circuit with active electrode 22 as well as the shaft of instrument 10.

[0014] Power is transmitted to active electrode 22 from power line 16 via a conductive element 26, such as a wire, as shown in FIG. 2. Return electrode 24, as described above, is preferably in the form of an electrically conductive shaft, preferably formed from 304 stainless steel or any other biocompatible conductive material, that extends from distal end 12 of instrument 10 to proximal end 14. The end of return electrode 24 adjacent proximal end 14 of instrument 10 is coupled to the power source to communicate the power source at proximal end 14 with distal treatment end 12 and thereby to complete the energy supply circuit of electrosurgical aspiration instrument 10. If desired, the shaft forming a return electrode 24 may be formed from a malleable material so that it is shapeable by the user. However, the distal-most end of instrument 10 should not be flexible. Additionally, any bend imparted to instrument 10 should not be so extreme as to close off the lumen formed therethrough and described in further detail below.

[0015] Electrodes 22 and 24 are electrically isolated from each other such that electrical arcing between active electrode 22 and return electrode 24 generates treatment energy along energy application surface 20 that may be applied to the patient. Electrical isolation or insulation of electrodes 22 and 24 at energy application surface 20 may be accomplished by the provision of insulator 28 therebetween. Insulator 28 is formed from any desired insulative material, such as ceramic, teflon or pyrolytic carbon, that may withstand the high temperatures that may result upon application of energy at distal end 12 during use of the instrument 10. Preferably, active electrode 22, return electrode 24, and insulator 28 permit fluid communication through instrument 10 from the treatment area at which energy application surface 20 is applied to proximal end 14, as described in further detail below.

[0016] In addition, electrodes 22 and 24 must also be electrically isolated axially along longitudinal axis 11 between proximal end 14 (at which instrument 10 applies treatment energy) so that power supply to energy application surface 20 is not shorted. Although insulation on wire 26 is typically sufficient to electrically insulate active electrode 22 from return electrode 24, optional insulation 30 on interior surface 32 of return electrode 24 may be provided. Insulation 30 is selected from biocompatible and electrically insulative material which could include nylon, polyimide or other shrink tubing and also functions to limit the heat transfer to the shaft. An insulative cover

34, such as formed from a teflon coating or a heat shrink cover, is provided over exterior surface 36 of return electrode 24 to restrict the extent of arcing and hence energy supplied to distal treatment end 12 of instrument 10.

[0017] Instrument 10 may be substantially straight, or may have a slight bend at distal end 12 such that energy application surface 20 is slightly offset from longitudinal axis 11. As shown in FIGS. 1 and 2, the energy application surface 20 of electrosurgical aspiration instrument 10 extends along distal end 12 (approximately transverse to longitudinal axis A-A in a straight instrument). However, it will be appreciated that electrodes 22 and 24 may be provided at different positions at distal end 12 to alter the location of energy application surface 20.

[0018] Electrosurgical aspiration instrument 10 may be used for a variety of electrosurgical treatments. One particular use of instrument 10 is for ablation of human or animal tissue. Because ablation generally occurs at very high temperatures, e.g. 300-1000 degrees Celsius, smoke and/or vapor may be generated during ablation. It may be desirable to remove smoke, a unwanted or excess gases (such as air bubbles) and fluids (such as irrigation fluid required to irrigate or enhance conduction after treatment) from the treatment area during treatment. Moreover, debris or other materials or biological elements may remain after the ablation procedure that should be removed from the treatment area. Thus, in accordance with the principles of the present invention, instrument 10 is also designed to aspirate such unwanted matter from the treatment area during the electrosurgical procedure performed thereby. It will be appreciated that aspiration may be performed either simultaneously with, before, or after electrosurgical treatment of an area. Further, it should be appreciated that a power source may be used which sequentially, or in a predetermined sequence, supplies power to the active electrode and then provides power for aspiration. Accordingly, an aspiration lumen 50 is provided within electrosurgical aspiration instrument 10 along longitudinal axis A-A. Preferably, aspiration lumen 50 has a diameter and extends through shaft 27. Aspiration lumen 50 may be formed by interior wall or surface 32 of return electrode 24 and is in fluid communication with an aspiration line 52 which couples proximal end 14 of instrument 10 with a vacuum source or other aspiration device (not shown). Aspiration line 52 is preferably standard tubing for connection to a suction source and device.

[0019] In order to facilitate aspiration during electrosurgical treatment, such as during ablation or coagulation, instrument 10 is provided with an aspiration means which permits aspiration through energy application surface 20. This is accomplished by providing at least one through-hole or aperture 25 through active electrode 22 which defines surface 20. Alternatively, a plurality of through-holes or apertures through active electrode 22 may be used to aid in aspiration of the electrosurgical probe. In the device of FIGS. 1 and 2, active electrode 22 is in the form of a wire mesh or screen 22A supported by an electrically conductive ring 22B. Mesh 22A and ring 22B comprising active electrode 22 are formed from a conductive materials, such as stainless steel, tungsten, or titanium or their alloys, that can withstand the high temperatures resulting from use of instrument 10. The entire mesh and ring of active electrodes 22 serves as the energy application surface and is powered by the power supply so that the electrosurgical application, such as ablation, occurs over the electrode. Thus, the active aspiration is approximately co-extensive with energy application surface 20. The preferred range of mesh sizes is from approximately 30 mesh to approximately 55 mesh.

[0020] The interstices between the mesh permit fluid communication therethrough such that unwanted matter (e.g., ablated tissue, smoke, air bubbles, and other elements or biological debris) may pass through the mesh and into aspiration lumen 50 for transport away form the treatment area. Moreover, because power is supplied substantially uniformly over the entire mesh of active electrode 22, unwanted matter that is too large to fit through the interstices of the mesh is caught on the mesh and accordingly ablated thereby when power is applied to the electroconductive mesh. As the mesh heats up, the matter is ablated until it becomes small enough to fit through the mesh. It will be appreciated that the energy application surface has a uniform electrical potential, being one piece across the surface of the mesh. Additionally, a blockage occurring at one portion of the mesh causes an increase in the suction force at unblocked portions of the mesh forming a non-uniform suction path. As the suction force increases in the unblocked areas, a differential axial suction force is created in which the blockage is turned and twisted to continue ablation and pass through apertures 25 to be aspirated through aspiration lumen 50. Thus, active electrode 22 not only provides treatment energy but also permits aspiration therethrough, as well as destruction of larger pieces of unwanted matter during aspiration which might otherwise clog the aspiration lumen 50.

[0021] Moreover, return electrode 24 is located on shaft 27 proximal to active electrode 22. This defines a unipolar configuration where the return electrode 24 has a larger surface area than active electrode 22. It functions as an indifferent return to the power source, and the energy is diffuse around electrode 24. This provides the active electrode 22 with a higher current density such that treatment energy is crowded and the treatment effect is generally in the area of tissue in proximity to active electrode 22.

[0022] Referring to FIG. 3, the electrosurgical probe of FIGS. I and 2 is illustrated in an end view. Mesh 22A of active electrode 22 forms the energy application surface. The spacing between the mesh form multiple apertures 25 to allows for suction of unwanted matter through the distal end and aspiration opening. Although a substantially flat piece of mesh may be used the mesh may be formed into any desired shape to vary the contour of the

contact surface provided by the mesh. For instance, the mesh forming active electrode 22 may be domed to conform substantially with concave body parts to be treated by electrosurgical aspiration instrument 10. Pointed, convex, rippled, or other contours may be provided instead, depending on user preferences or other contours of the area to be treated. Insulator 28 electrically isolates active electrode 22 from return electrode 24.

[0023] An embodiment is illustrated by FIG. 4A in which electrosurgical instrument 1310 has an ashtray configuration of the active electrode 1322. Active electrode 1322 is located on the distal end 1312 of shaft 1327. The instrument shaft may be covered with shaft insulator 1334. Active electrode 1322 is in an ashtray configuration where cutouts 1329 are formed in energy application surface 1320. By forming cutouts 1329, edges 1380 are formed within the energy application surface 1320 of active electrode 1322. Edges 1380 form both a mechanical tissue removal surface and a current crowding edge for maximum energy delivery effect. Blockage of aperture 1325 can also be prevented and eliminated by configuring active electrode 1322 with edges 1380 near the aperture 1325. Electrical conductor 1316 electrically couples the electrode 1322 to the power source (not shown). Active electrode 1322 is configured with a central aperture 1325 which communicates with aspiration lumen 1350. Return electrode 1324 is located within aspiration lumen 1350 and is proximal to active electrode 1322 to form a boiling chamber so that material aspirated through the aperture 1325 and past the active electrode 1322 increase the impedance to increase the delivery of energy to the region between the electrodes, so that the matter is ablated as described above. Insulator 1328 insulates electrodes 1322 and 1324. An internal lining 1330 may also line aspiration lumen 1350 to function as both an electrical and thermal insulator.

[0024] FIG. 4B is a perspective view of FIG. 4A in which the active electrode 322 is shown in the ashtray configuration. Cutouts 1329 within the electrode define edges 1380 to serve as mechanical cutting surface edges current crowding edges for effective ablation. Aperture 1325 communicates through instrument 1310 with aspiration lumen 1350. FIGS .13A and 13B illustrate an ashtray electrode inside an indifferent electrode and suction through the electrode.

[0025] FIGS. 5A and 5B illustrate cross-sectional and perspective views of an alternative embodiment of the electrosurgical aspiration instrument 1310 as described FIGS. 4A and 4B. Similar elements will be referenced to FIGS. 4A and 4B. In this embodiment, return electrode 1424 is located external along the shaft 1427. Return electrode 1426 electrically completes the current path to the power source from the active electrode 1422. The return electrode 1424 is preferably a ring electrode located on the surface of shaft 1427 and is isolated from the active electrode 1422 by insulator 1428. FIGS. 14A and 14B illustrate an ashtray electrode outside an indifferent electrode and suction through the lumen.

[0026] FIGS. 6A-C illustrate different views of ashtray electrode according to one alternative embodiment of the active electrode as described above. Like elements will be referenced by the same reference numbers. FIG. 6A shows a close-up perspective view of cove electrode 1522 in which at least one aperture 1525 is provided through active electrode 1522. Active electrode 1522 is configured to crowd the current creating a high current density along a circumferential edge 1580. Edge 1580 defines energy application surface 1520. Cutouts 1529 form a pattern along edge 1580 to maximize the current crowding. As the current is crowded along edges 1580, a mechanical scraping and ablative effect occurs simultaneously. Current is also crowded at the edge 1580a formed within aperture 1525 to prevent blockage of the aperture. As energy is applied to the active electrode, the sharp edge of surface 1580 provides both a surface for the delivery of RF power for ablation and a mechanical grating or scraping surface for scraping tissue at the surgical tissue site. It will be appreciated that edge 1580 of electrode 1520 may be rounded such that a smoothing surface may be formed and sculpting may be performed with he instrument of the present invention.

[0027] As by-products of ablation and/or coagulation are created at the surgical site, negative pressure created by suction through the lumen and electrosurgical instrument aspirates the additional matter through aperture 1525. However, blockage and clogging of the aperture 1525 may undesirably increase the ablation effect by reducing the flow of liquid and tissue through aperture 1525. By-products of surgery such as biological tissue debris could result from the ablation and cutting process. As this matter becomes dislodged and freely movable within the surgical site, the biological tissue may completely block any and all apertures into the instrument. Thus, the cooling effect due to the flow of matter and liquid is reduced thereby increasing the delivery of treatment energy to the site possibly causing unnecessary ablation and injury to the patient.

[0028] When impedance increases due to blocked tissue within aperture 525, the tissue is further treated with energy at edges 1580 a whereby the tissue is further ablated to a size to fit through aperture 1525. The irregular shape of aperture 1525 in combination with edge 1580 a provides for non-uniform and non-round apertures such that both an electrical and mechanical effect combine to prevent blockage within the opening thereby increasing the efficiency of the electrosurgical instrument 1510.

[0029] FIG. 6B shows an end view of the distal electrode tip 1512. Energy application surface 1520 and edge 1580 are shown with cutouts 1529. It will also be appreciated that the number, sizes and placement of cutouts 1529 within surface 1520 may vary to provide different ablation effects and patterns. The electrical current is crowded and as the greatest density at surface 1520 and edge 1580 such that ablation, cutting and/or coagulation occurs along edge 1580.

[0030] FIG. 6C is a cross-sectional view of the distal tip of FIG. 6B in which the active electrode 1522 on distal end 1512 is shown along Line A-A. The energy application surface 1520 is shown in detail as a sharp edge 1580 with both an electrical effect for ablation and mechanical effect for scraping. Edge 1580 is shown to be intruding into a portion of aperture 1525 which leads to aspiration lumen 1550. The effect of suction through a non-uniform configuration of aperture 1525 prevents the blockage and clogging of the aspiration opening such that the negative pressure pulls the blockage into the lumen across different axial planes. For example, as an unwanted by-product matter hits aperture 1525, it lodges on a portion of edge 1580a. As the suction is applied to the lumen and through the opening, a portion of the matter is pulled on the portions away from the lodged portion along edge 1580a. This allows the matter to twist and turn in different axial planes whereby the unwanted matter moves and has a different and more compatible physical orientation to move through aperture 1525.

[0031] FIG. 7 illustrates a perspective view of an electrosurgical aspiration .instrument 1910 according to the present invention. Aspiration line 1952 is attached to proximal handle 1917. Aspiration line 1952 connects to a suction device and receptacle (not shown) which provides a negative pressure through the instrument in order to aspirate ablation by-products through distal tip 1912 through probe shaft 1927. A power receptacle 1914 connects instrument 1910 to a power source (not shown). An actuator 1918 controls the amount and force of suction through the aspiration line 1952 and is controlled by a roller. Vacuum line connector 1957 connects to the aspiration receptacle. It will be appreciated that any device or mechanism to control the amount and force of suction may be used to aspirate surgical material through the instrument 1910.

[0032] FIGS. 8 and 9 show two alternative embodiments of the distal end 1912 of FIG. 7 of the present invention in which the shaft 1927 of distal end 1912 is pre-bent. As discussed above, it is preferable that the shaft 1927 is not flexible such that the aspiration lumen is not pinched nor crimped thereby blocking suction. The reduction of the suction force as discussed above may lead to an increase in the ablation effect. FIG. 8 shows a 30 degree bend in distal end 1912 and FIG. 9 is a 90 degree bend. The degree of pre-bent angle is not limited to these specific degrees.

[0033] In order to perform an ablation function, the energy supplied to the electrosurgical aspiration instrument should be in the range of 100-500KHz. This range may be varied depending on the materials used to form the instrument as well as depending on the particular application of the instrument in the surgical procedure. The lowest frequency used typically is selected such that use of the instrument does not interfere with other tissue nor stimulate nerves in the area. Thus, isolated treatment of the selected tissue area is permitted. The highest frequency used typically is limited depending on the desired results that would be achieved by such frequency. For instance, at too high a frequency, appropriate ablation may not be achievable and blockage of the lumen by debris may occur.

[0034] Power may be provided by commercially available RF energy sources. Such RF energy sources may include generators which control the temperature of the electrosurgical instrument. Power may also be regulated by feedback to prevent overpower and undesired ablation or coagulation as such.

[0035] As mentioned above, the electrosurgical instrument of the present invention may be used for any of a variety of applications and procedures, depending on the nature of the energy supplied thereto by the power source. It will, therefore, be appreciated that the energy supplied to the electrosurgical instrument of the present invention may be varied depending on the application desired. The energy level may even be varied during use to perform a variety of functions, such as ablation followed or accompanied by cauterization or coagulation as necessary.

[0036] The present invention provides a surgical instrument for use in a method for the application of energy to a treatment area of a patient and for the aspiration of unwanted matter, such as smoke, air bubbles and biological waste debris from the surgical site.

[0037] Desirably, the combination of electrosurgical and aspiration instrument provides an energy application surface area that applies energy uniformly over the treatment area and also permits aspiration therethrough so as to limit clogging.

[0038] The instrument has both an active electrode and a return electrode at a distal tip of the instrument. Desirably energy distribution is substantially limited to the distal tip surface. In use, the instrument is coupled to an energy generator that preferably includes controls that may be used to regulate the power, frequency, and voltage applied to the instrument to vary the type of treatment for which the instrument is used. The regulation may include feedback controls.

[0039] In one embodiment of the invention, the active electrode is provided with a plurality of small passages therethrough in a fluid communication with the suction lumen of the instrument. Thus, aspiration of the treatment area occurs through at least a portion of the energy application surface. If desired, both the active and return electrodes may be positioned in substantially the same plane such that energy distribution is substantially restricted to a substantially planar surface area, such as the surface area of the distal tip.

[0040] As negative pressure is applied to the lumen, matter that is in the surgical site is aspirated through the aspiration opening. The opening is configured to prevent clogging of the aspirated matter at the distal end. The aspiration opening may be defined by the active electrode which is configured to prevent clogging of the aspiration opening and allow continued desiccation of the unwanted aspirated matter such that the matter will move

easily through the aspiration lumen.

[0041] One method of electrosurgically treating tissue at a surgical site employing an instrument according to the present invention includes positioning an energy application surface adjacent or in contact with tissue to be treated, applying energy across the energy application surface to the treatment area, aspirating matter generation as a result of the energy application through the energy application surface, and applying energy to the aspirated materials passing through the energy application surface.

[0042] Optionally, the energy used to practice the method of electrosurgically treating tissue is radiofrequency energy. Optionally, the aspirating step of electrosurgically treating tissue occurs over a non-uniform plane creating a differential suction of a blockage across the energy application surface to facilitate aspiration of the blockage through the energy application surface.

Claims

1. A surgical instrument (1310) comprising an elongate probe member (1327) having proximal and distal (1212) extremities, the elongate member (1327) having an aspiration lumen (1350) extending from the proximal extremity to an opening at the distal extremity (1312) and electrode means (1322, 1324) carried by the distal extremity of the elongate probe member (1327), wherein the electrode means extends across at least a portion of the opening, and wherein the electrode means includes an active electrode (1322) and a return electrode (1324) mounted on the distal extremity adjacent the opening whereby, in use, radio frequency energy passes from the active electrode (1322) across at least a portion of the opening to the return electrode (1324) when radio frequency energy is supplied to the active electrode (1322); said active electrode (1322) having an opening (1325); **characterised in that** the cross-sectional area of said active electrode opening (1325) is smaller than the cross-sectional area of the lumen (1350) for inhibiting clogging of aspirated material in the lumen; and **in that** said active electrode (1322) is of ashtray configuration, having an energy application surface (1320) surrounding said active electrode opening (1325), the periphery of said surface (1320) having a multiplicity of cutouts (1329) which define edges adapted to serve as mechanical cutting edges and current crowding edges,

2. The surgical instrument of claim 1 wherein the elongate member (1327) serves as a conductor for the active electrode (1322) or the return electrode (1324).

3. The surgical instrument of claim 1 or claim 2 wherein the return electrode (1324) is located within the aspiration lumen (1350).

4. A surgical instrument according to any preceding claim wherein the aspiration lumen (1350) has an internal lining (1300) which is a thermal and electrical insulator.

5. The surgical instrument of any preceding claim further comprising a suction source coupled to the elongate member for providing negative pressure to the lumen for aspirating matter through the opening.

Patentansprüche

1. Chirurgisches Instrument (1310), umfassend ein längliches Sondenelement (1327) mit einem proximalen und einem distalen (1212) Ende, wobei das längliche Element (1327) ein Aspirationslumen (1350), welches sich von dem proximalen Ende zu einer Öffnung am distalen Ende (1312) erstreckt, und ein Elektrodenmittel (1322, 1324) aufweist, das von dem distalen Ende des länglichen Sondenelements (1327) gehalten ist, worin sich das Elektrodenmittel zumindest über einen Abschnitt der Öffnung erstreckt und worin das Elektrodenmittel eine aktive Elektrode (1322) und eine Rückelektrode (1324) umfasst, die auf dem distalen Ende benachbart zur Öffnung angebracht ist, wodurch - in Verwendung - Hochwellenfrequenzenergie von der aktiven Elektrode (1322) über zumindest einen Abschnitt der Öffnung zur Rückelektrode (1324) gelangt, wenn die aktive Elektrode (1322) mit Hochfrequenzenergie gepeist wird, wobei die aktive Elektrode (1322) eine Öffnung (1325) aufweist, **dadurch gekennzeichnet, dass** der Querschnittsbereich der aktiven Elektrodenöffnung (1325) zur Vermeidung des Verlegens des Lumens durch angesaugtes Material kleiner als der Querschnittsbereich des Lumens (1350) ist und dass die aktive Elektrode (1322) einen Aschenbecher-Aufbau mit einer Energieanlegungsoberfläche (1320) aufweist, die die aktive Elektrodenöffnung (1325) umgibt, wobei der Umfang der Oberfläche (1320) eine Vielzahl an Ausschnitten (1329) zur Definition von Kanten aufweist, die ausgebildet sind, um als mechanische Schnittkanten und Stromeinschnürungskanten zu wirken.

2. Chirurgisches Instrument nach Anspruch 1, worin das längliche Element (1327) als Leiter für die aktive Elektrode (1322) oder die Rückelektrode (1324) dient.

3. Chirurgisches Instrument nach Anspruch 1 oder 2, worin die Rückelektrode (1324) innerhalb des Aspirationslumens (1350) angeordnet ist.

4. Chirurgisches Instrument nach einem der vorange-

gangenen Ansprüche, worin das Aspirationslumen (1350) eine Innenauskleidung (1300) aufweist, welche ein elektrischer und ein Wärmeisolator ist.

5. Chirurgisches Instrument nach einem der vorangegangenen Ansprüche, ferner umfassend eine Saugquelle, die mit dem länglichen Element zum Bereitstellen negativen Drucks am Lumen zum Ansaugen von Materie durch die Öffnung gekoppelt ist.

Revendications

1. Instrument chirurgical (1310) comprenant un élément de sonde allongé (1327) ayant des extrémités proximale et distale (1212), l'élément allongé (1327) ayant une lumière d'aspiration (1350) s'étendant de l'extrémité proximale jusqu'à une ouverture au niveau de l'extrémité distale (1312), et des moyens d'électrode (1322, 1324) supportés par l'extrémité distale de l'élément de sonde allongé (1327), dans lequel les moyens d'électrode s'étendent sur au moins une partie de l'ouverture, et dans lequel les moyens d'électrode comprennent une électrode active (1322) et une électrode de retour (1324) montées sur l'extrémité distale adjacente à l'ouverture, moyennant quoi à l'usage l'énergie haute fréquence passe par l'électrode active (1322) sur au moins une partie de l'ouverture jusqu'à l'électrode de retour (1324) lorsque l'énergie haute fréquence est alimentée à l'électrode active (1322) ; ladite électrode active (1322) ayant une ouverture (1325) ; **caractérisé en ce que** la surface transversale de ladite ouverture (1325) de l'électrode active est inférieure à la surface transversale de la lumière (1350) pour empêcher l'obturation de la matière aspirée dans la lumière ; et **en ce que** ladite l'électrode active (1322) a une configuration de cendrier, ayant une surface d'application d'énergie (1320) entourant ladite ouverture (1325) de l'électrode active, la périphérie de ladite surface (1320) ayant plusieurs découpes (1329) qui définissent des bords adaptés à servir de bords de coupe mécanique et de bords de défocalisation.

2. Instrument chirurgical selon la revendication 1, dans lequel l'élément allongé (1327) sert de conducteur pour l'électrode active (1322) ou l'électrode de retour (1324).

3. Instrument chirurgical selon la revendication 1 ou la revendication 2, dans lequel l'électrode de retour (1324) est positionnée dans la lumière d'aspiration (1350).

4. Instrument chirurgical selon l'une quelconque des revendications précédentes, dans lequel la lumière d'aspiration (1350) a un revêtement interne (1300) qui est un isolant thermique et électrique.

5. Instrument chirurgical selon l'une quelconque des revendications précédentes, comprenant en outre une source d'aspiration couplée à l'élément allongé pour fournir une pression négative à la lumière afin d'aspirer la matière par l'ouverture.

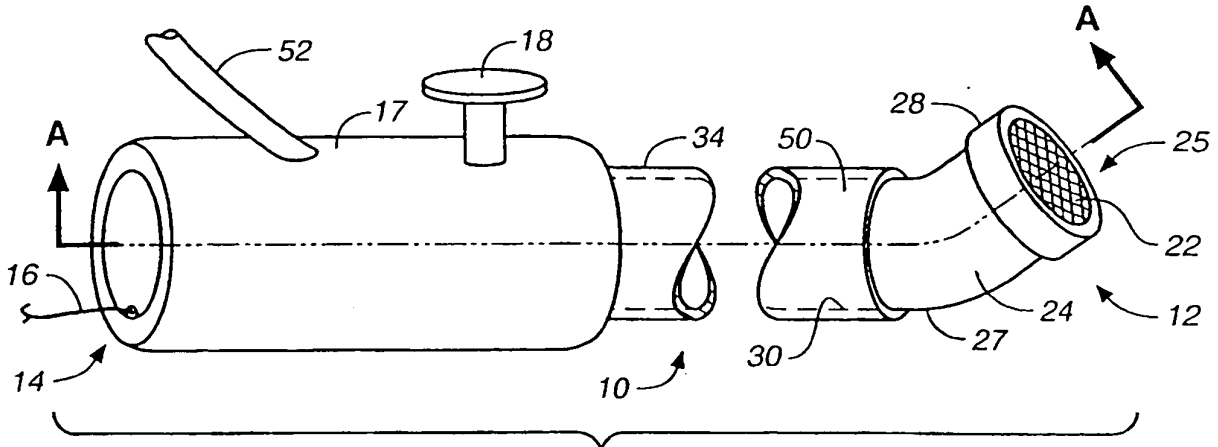

FIG._1

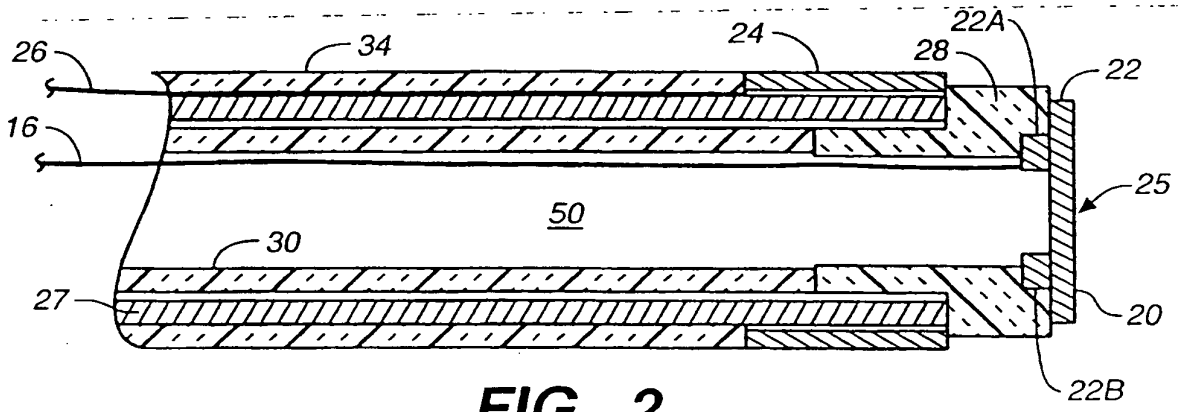

FIG._2

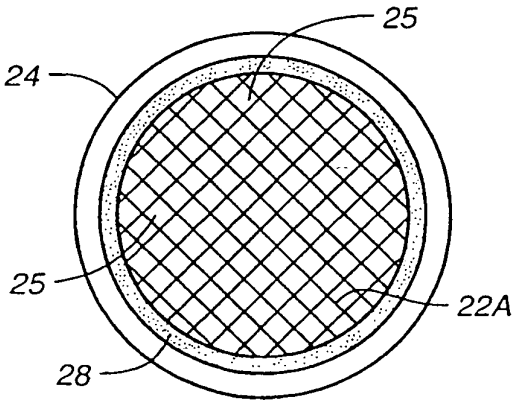

FIG._3

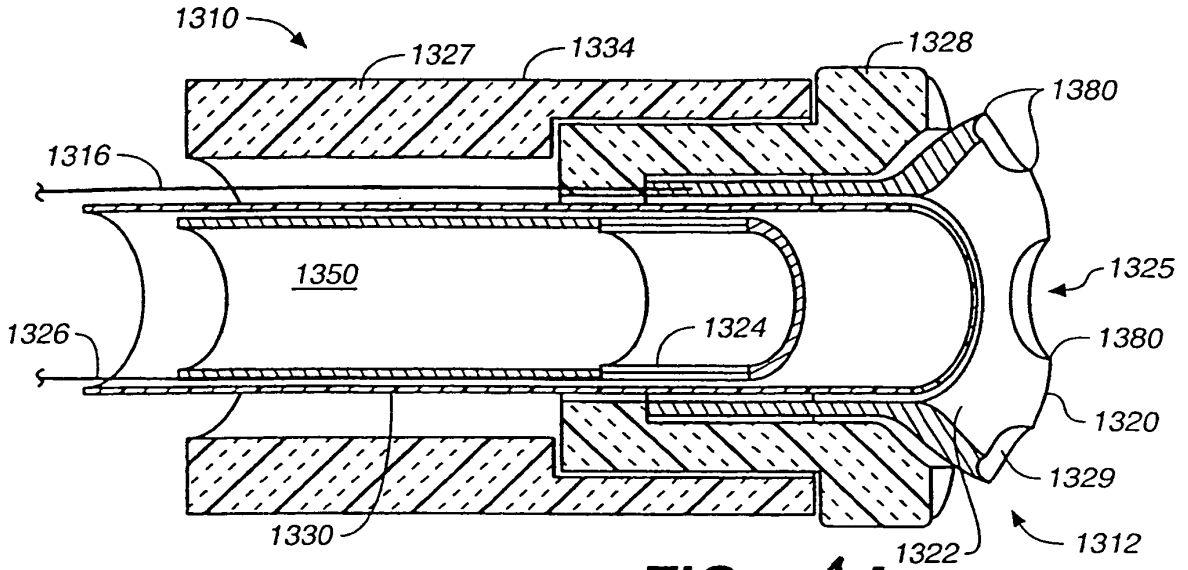
1310
1327
1334
1328
1380
1316
1350
1325
1326
1324
1380
1320
1329
1330
1322
1312

FIG._ 4A

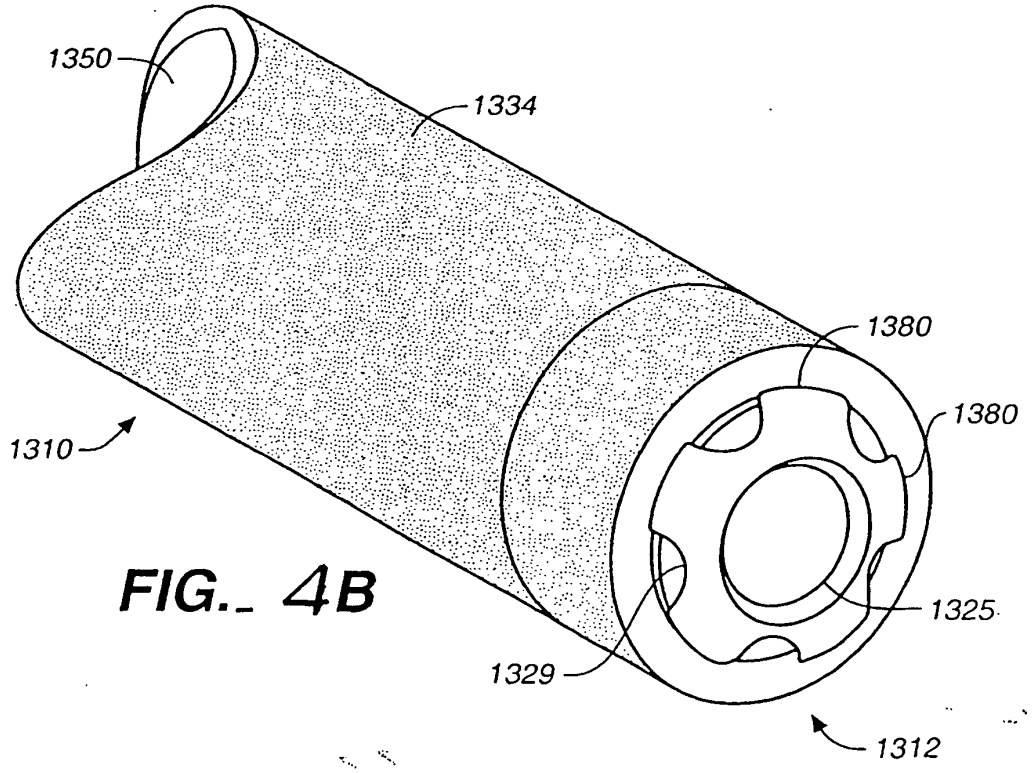
1350
1334
1380
1380
1310
1325
1329
1312

FIG._ 4B

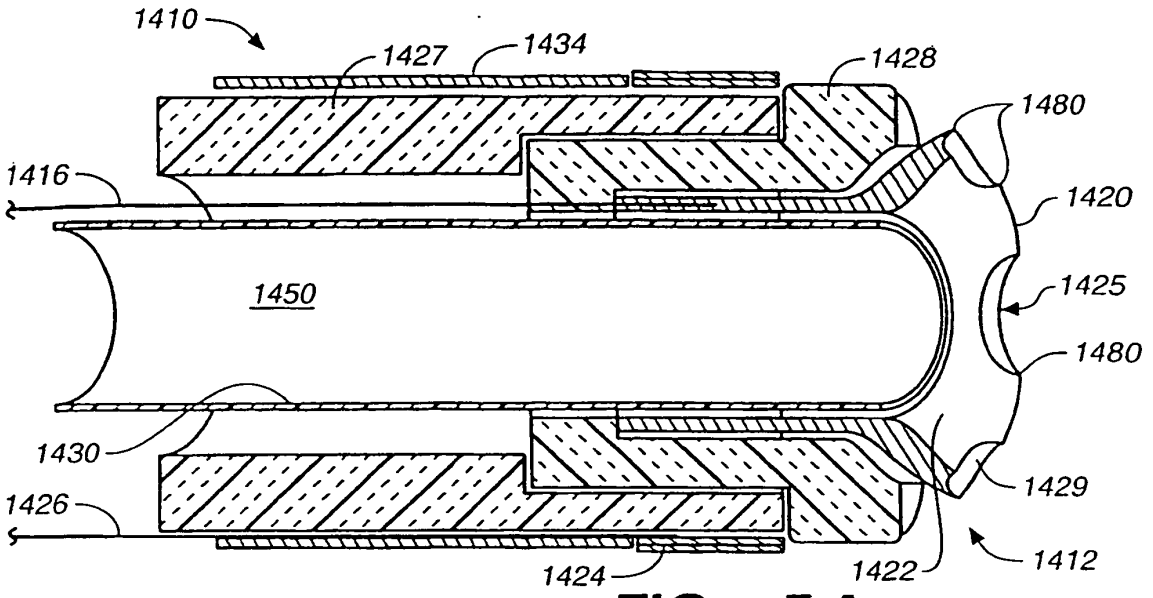
1410
1427
1434
1428
1480
1416
1420
1450
1425
1480
1430
1429
1426
1412
1424
1422

FIG._ 5A

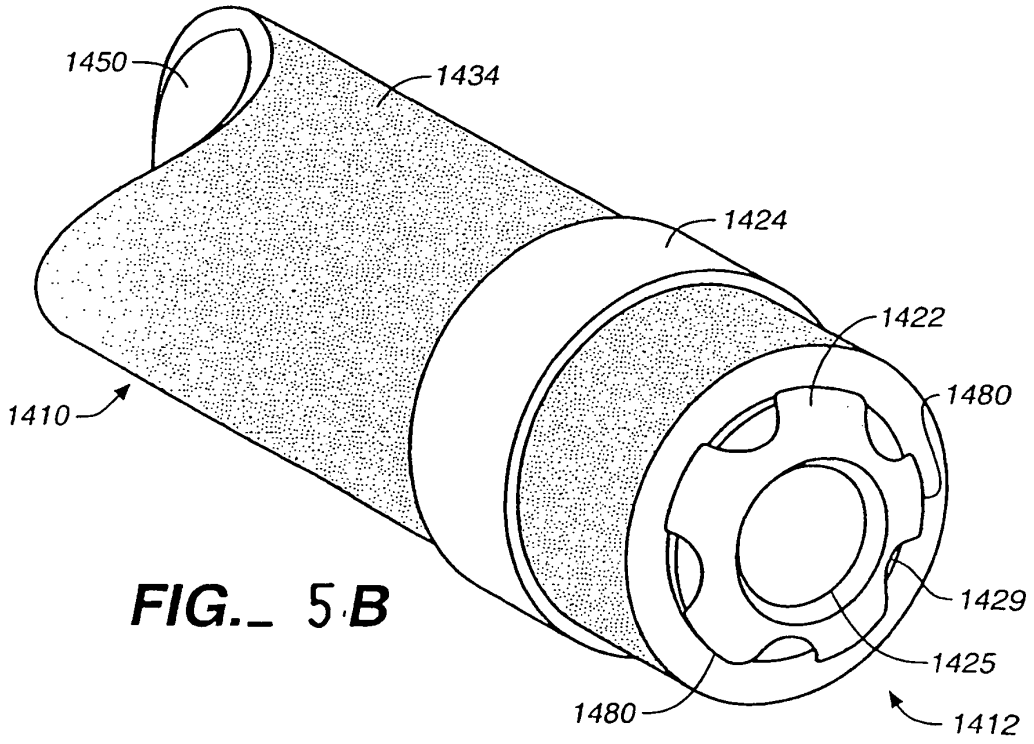
1450
1434
1424
1422
1480
1410
1429
1425
1480
1412

FIG._ 5B

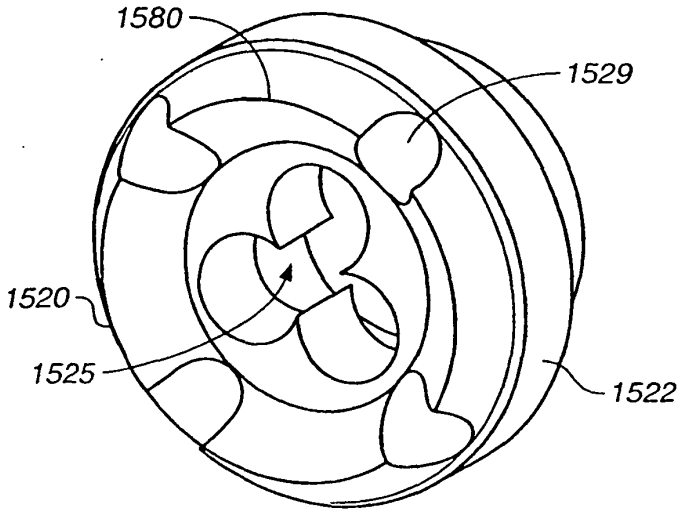

FIG._ 6A

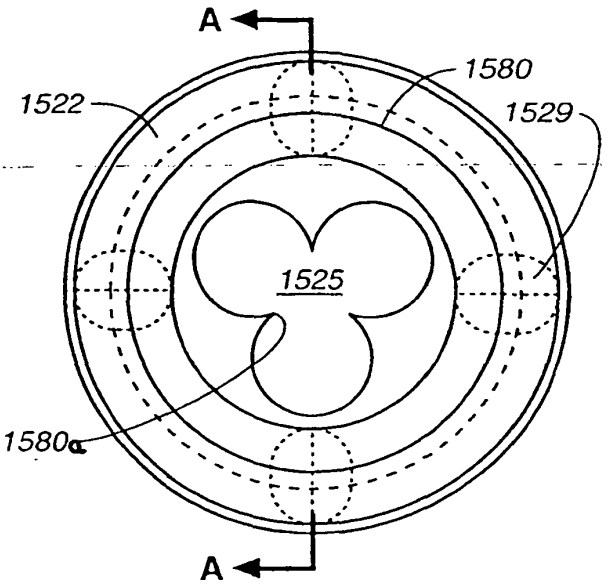

FIG._ 6B

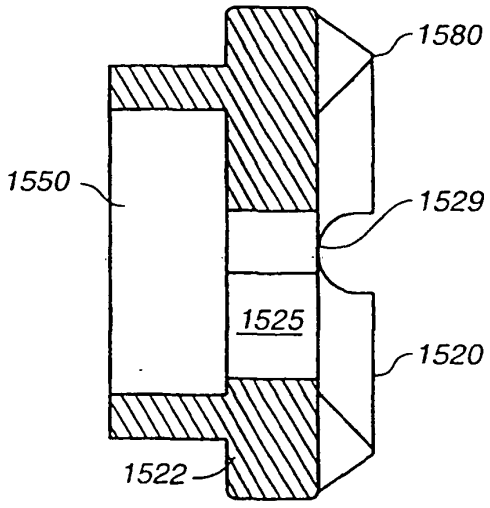

FIG._ 6C

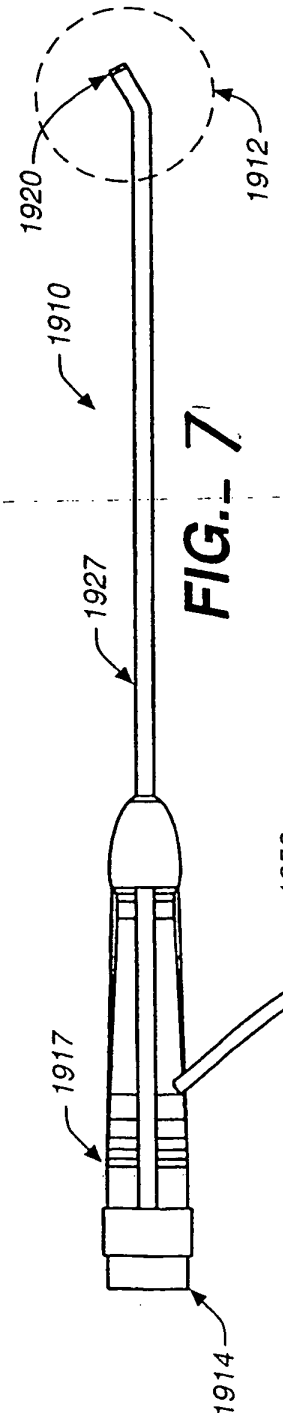

FIG._7

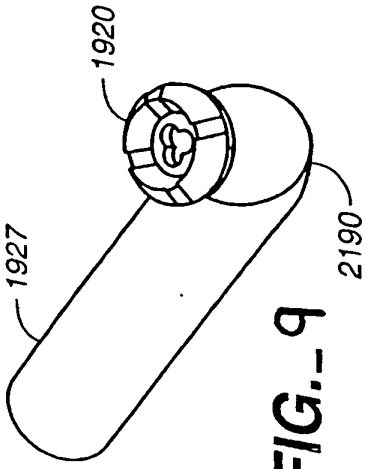

FIG._9

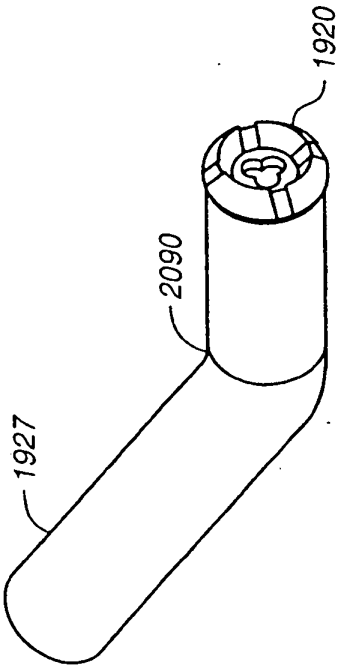

FIG._8

REFERENCES CITED IN THE DESCRIPTION

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